Biennial Science Work Plan

Purpose, Audience, and Roles in the Plan Development
August 5, 2008

The legislation establishing the Puget Sound Partnership requires that a Biennial Science Work Plan (BSWP) accompany the 2008 Action Agenda. The legislation specifies that BSWP shall:

- Identify research recommendations from scientific and technical reports relating to Puget Sound;
- Describe Puget Sound science-related activities being conducted by various entities in the region;
- Conduct a gap analysis of whether the ongoing activities address recommendations;
- Identify work plan actions and how they address science needs; and
- Make recommendations for ongoing science work improvements in Puget Sound.

This document lays out a draft BSWP purpose, intended audience, and the roles of the Science Panel and the Leadership Council in producing the plan.

Purpose: The purpose of the BSWP is to identify near-term priority science actions (two-year window) that are needed to (1) provide a solid science foundation to the Puget Sound Partnership Action Agenda (2008 and future updates), and (2) chart the best course to a recovered Puget Sound.

Audience: The intended audience for the BSWP is individuals, organizations, and agencies that conduct or manage research. Through the BSWP, they can have a clear picture of the pressing science needs in Puget Sound, align their work with the science priorities of the region, and understand Partnership funding opportunities to support their work.

Science Panel and Leadership Council roles: The BSWP is a product of the Science Panel (SP). The SP will be assisted by staff from the Puget Sound Partnership. Specific tasks for the SP include:

- Identifying near-term priority research needs by topic area;
- Determining system-wide priority needs and cross-cutting research issues;
- Writing the BSWP (with staff support as needed);
- Reviewing the draft BSWP.

The SP will discuss a proposed outline for the BSWP, review of inventories of recommendations for scientific studies and recent/ongoing studies, and determine system wide priorities and issues on August 6. A draft BSWP will be prepared by September 10 and a proposed final BSWP will be released to the Leadership Council by October 3. The Leadership Council will preliminarily approve the BSWP as an element of the 2008 Action Agenda on October 22 or 23.

Biennial Science Work Plan Timeline:

Project staffing:
Project oversight and guidance: Science Panel- Joel Baker, PSP- Scott Redman
Project management: Julie Hall
Project assistance: ESA Adolfson – Ken Yocom, Ilon Logan, Scott Olmsted
Biennial Science Work Plan development: Science Panel (SP) work team (members TBD)

Task	Deadline	Staffing
Project Start	June 12	Julie, Ken, Ilon and Scott O
Inventory of science study recommendations	July 23	Lead: Ilon and Scott O Julie to provide direction
Inventory of recent/ongoing research	July 23	Lead: Ilon and Scott O Julie to provide direction
Preliminary research/modeling gap analysis results	July 23	Lead: Julie Ken, Scott O, and Ilon support
Science Panel conference call: review inventory and gap analysis, discuss BSWP intended use and outline	July 25	Lead: Scott R and Julie
Science Panel to provide additional inventory entries	August 1	Lead: Science Panel members
Science Panel topic leads to identify top 3-4 research/modeling priorities	August 1	Lead: Science Panel topic leads
Draft BSWP outline complete	August 6	Lead: Scott R and Julie
Science Panel meeting: ▪ Finalize BSWP outline ▪ Identify system-wide priorities for 2009-2011 ▪ Monitoring tie-in	August 6-7	Lead: Scott R and Julie Input from Science Panel
Drafting of the BSWP	August 11-September 5	Lead: SP work team Julie and Scott R to support
BSWP briefing to Leadership Council	September 4-5	Lead: Joel and Scott R Julie support
Draft BSWP complete ▪ Distributed to Science Panel members for review	September 10	Lead: SP work team Julie support
Science Panel review complete	September 16-17	Lead: Science Panel members
Revisions to draft BSWP	October 1	Lead: Joel, SP work team Julie support

Task	Deadline	Staffing
Release proposed final BSWP to Leadership Council	October 3	Lead: Scott R and Julie
Leadership Council's preliminary approval	October 22-23	Lead: Joel and Scott R Julie support
Revisions to proposed final BSWP	October 30	Lead: Joel, SP work team Julie support
Final plan complete	November 7	Julie to provide final document to PSP PSP to produce final for inclusion with Action Agenda

Biennial Science Work Plan

Proposed Outline

1. Executive Summary (one page summary of priority research and monitoring work, organized as bullets under the 3 major SSP questions)

2. Introduction (keep to 2 pages maximum)
    - Issues facing Puget Sound
    - Role of the Puget Sound Partnership and Science Panel
    - Purpose of the Biennial Science Work Plan
    - Connection with the Strategic Science Plan

3. SSP Question 1: How is the Puget Sound ecosystem, including social and economic systems, structured and how does it work?

(This is mostly going to be research and modeling, as one-time studies, which help us understand the ecosystem, based mostly on the research inventory and gap work)

- 3.1 Overall system-wide priorities and rationale (inventory of recommended research noted as appendix)
- 3.2 Summary of ongoing/recent studies for those priorities
- 3.3 Focus for 2009-2011
    - 3.3.1 Specified studies (continuing and/or new)
    - 3.3.2 Questions and hypotheses to study through competitive programs

4. SSP Question 2: How has the Puget Sound ecosystem and social and economic systems changed and what will it look like in 2020? i.e. What trajectory are we on?

(This is status and trend monitoring and modeling, on-going work, which helps us track the ecosystem direction, based mostly on the monitoring work by Ralph/Currens, and monitoring inventory work by JSA/Cherry Creek)

- 4.1 Overall system-wide priorities and rationale (review/compilation of status and trend assessment questions noted as appendix)
- 4.2 Summary of ongoing/recent studies for those priorities (monitoring inventory noted as appendix)
- 4.3 Focus for 2009-2011
    - 4.3.1 Continue ongoing studies
    - 4.3.2 Initiate new studies
    - 4.3.3 Develop a coordinated monitoring program

5. SSP Question 3: How can we best inform management of the Puget Sound ecosystem to meet the six PSP goals and how will those actions affect social and economic systems? i.e. How can we change it for the better?

(This is effectiveness monitoring and prioritization modeling, which helps us understand what specific actions accomplish in terms of an ecosystem benefit, again base mostly on the monitoring work by Ralph/Currens, and monitoring inventory work by JSA/Cherry Creek)

- 5.1 Overall system-wide priorities and rationale (inventory of recommended research & monitoring inventory noted as appendix)
- 5.2 Summary of ongoing/recent studies for those priorities
- 5.3 Focus for 2009-2011
  - 5.3.1 Continue ongoing programs and studies
  - 5.3.2 Initiate new studies

6. Work Plan Conclusions: 2009-2011 (2 pages max)
   - Summary of priorities
   - Consistency with Puget Sound science needs
   - Recommendations for Improving Science Work in Puget Sound (required by legislation)

Appendices (most required by legislation)

- Inventory of science study recommendations
- Inventory of recent and ongoing research
- Gap analysis
- Inventory of monitoring
- Status and trend assessment questions

Four elements of Section V (implementation) of Strategic Science Plan

- Modeling
- Research
- Monitoring
- Information Management

Four analytic questions organizing the Action Agenda

- What is the status of Puget Sound are what are the biggest threats to it?
- What is a healthy Puget Sound?
- What do we need to do to move from where we are today to a healthy Puget Sound?
- Where should we start?

Six goals for Puget Sound recovery

- A healthy human population supported by a healthy Puget Sound that is not threatened by changes in the ecosystem

- A quality of human life that is sustained by a functioning Puget Sound ecosystem

- Healthy and sustaining populations of native species in Puget Sound, including a robust food web

- A healthy Puget Sound where freshwater, estuary, near shore, marine, and upland habitats are protected, restored, and sustained

- An ecosystem that is supported by ground water levels as well as river and stream flow levels sufficient to sustain people, fish, and wildlife, and the natural functions of the environment

- Fresh and marine waters and sediments of a sufficient quality so that the waters in the region are safe for drinking, swimming, shellfish harvest and consumption, and other human uses and enjoyment, and are not harmful to the native marine mammals, fish, birds, and shellfish of the region

Initial Thoughts:
Research Priorities for 2009-2011 Biennial Science Work Plan
8/6/08

Topic: Human Health

Science Panel input:

None

Topic Forum Paper:

- Determine the contribution of pathogen loading to Puget Sound from large and small vessels.
- Determine the contribution of pathogen loading to Puget Sound from aging and/or under functioning on-site sewage systems.
- Determine the extent and level of threat of the "emerging" pathogens and biotoxins.
- Effects of climate change on pathogens and toxins.
- Assess toxics in water column.
- Assess the chemical contamination of other species in Puget Sound.
- Assess the chemical contamination of shellfish and crab in Puget Sound.
- Comprehensive study of fish consumption.
- Cumulative impacts of multiple contaminants.
- Expand the swimming beach program.
- Develop a comprehensive inventory of data being collected for human health.
- Evaluate the effectiveness of public education and outreach programs regarding human health (fish consumption, beach use, etc.).
- Broad risk assessment for toxics in shellfish.
- Assess toxics and pathogens in crab.
- Assess groundwater and freshwater toxics entering Puget Sound.
- Assess extent of shellfish harvest on private beaches and associated human health risk.

Preliminary Gap Analysis:

- Tracing contaminants from sources to sinks, including accumulation in trophic levels and eventual effects to humans based on consumption.

- Better understanding how humans are affected by contaminants in shellfish, fish, and other aquatic species, including better estimates of consumption and cumulative effects of multiple pollutants.
- Better understanding the effects of air pollution and emissions on human health.
- Increasing monitoring of swimming beaches for pathogens.
- Examining human health risks of infiltrated pollutants and groundwater/surface water interactions with algal blooms.

Topic: Human Well Being (HWB)

Science Panel input:

- Washington State institutional analysis (Trina).
- Baseline economic valuation of both market and non-market goods and services provided by Puget Sound (Trina).
- Collaborative modeling of the linkages between the Puget Sound ecosystem and social and economic systems (Trina).
- Public surveys to assess opinions, perspectives, and potential behavioral change related to alternative regulatory or incentive based management strategies (Trina).

Topic Forum Paper:

- Develop a better understanding of the linkages between Puget Sound ecosystem services and human well being. Questions could include 1. How do specific changes in Puget Sound health affect specific quality of life attributes? 2. Do these effects differ (and if so how) across geographic areas of the Sound, population sectors, or business/economic sectors? 3. How do the ecological scales of ecosystem services in the Sound differ from (or match) the governance, management, or regulatory jurisdictional divisions of the Sound? 4. Who uses and produces ecosystem services? What are the ecological and social scales of ecosystem services? (i.e., at what scales are benefits provided? At what scales is management most effective?).
- Support and/or coordinate with a set of demonstration futures analysis.
- Conduct an institutional analysis of all state and local agencies engaged in environmental management with a focus on activities that invest in the enhancement of Puget Sound and its biota.
- Need Conceptual models to effectively articulate the impacts of certain driving forces on various ecosystem states, identify potential conflicts or tradeoffs, and propose responses that will result in the greatest benefit to both people and their surrounding ecosystems as we move through the adaptive management process.
- Continue to establish a meaningful and effective set of measurable HWB indicators.
- Continue to develop conceptual models of how human well being plays a role in ecosystem management as indicated above.
- Continue to develop the integration of the current WRI/TNC/NOAA ecosystem services assessment with the assessments done through the topic forum and indicators work.
- Continue work on the Finance Strategy, noting that "affordability" of actions must be evaluated at the sub-basin scale and that ecosystem losses due to degradation of habitat and water must be balanced against all possible management strategies

including regulatory protection, acquisition and other private agreements, and restoration or mitigation of lost services.

- Evaluate how HWB is and has been incorporated into successful ecosystem management solutions here and in other parts of the country and the world, and identify examples of how attributes of HWB can be woven into future iterations of the PSP Action Agenda.
- Complete a comprehensive review of the types of resource management approaches to identify those most effective in modifying human behavior under varying ecological, social and economic conditions.
- Quantifying, where possible, or at least qualify the potential impact of various resource management approaches on the Puget Sound economy.
- Quantify where possible or qualify the impact of various resource management approaches on other aspects of the HWB – besides the economy – such as sense of place and community, cultural identity, respect for other cultures and good social relations.

<u>Preliminary Gap Analysis:</u>

- Better linking the provision of ecosystem services to human well being.

Topic: Species, Biodiversity & Food webs

Science Panel input:

- Forage fish populations, stressors on these populations, and pelagic food web implications (this is a big black hole, scientifically) (Frank).
- Invasive species propagule warning systems (particularly ballast water) for invasion prevention (Frank).
- Emerging diseases, including effects of climate change (marine mammals, fish) (Frank).

Topic Forum Paper:

- Nothing is known about the abundance, diversity, productivity and distribution of thousands of Puget Sound species or how those link to ecosystem processes.
- Assess harvest and culture practices; Conduct a critical assessment of harvest and culture practices to see where they could be improved, particularly regarding maintaining harvested species' roles in the ecosystem and ensuring that culture practices protect the ecosystem. Adjust practices as necessary to restore ecosystem.
- Build understanding of food webs, threats, and effectiveness of our management actions.
- Continue to conduct research on trends, patterns, and mechanisms of change in species, biodiversity, and the food web. Also need to be able to discriminate between natural and human-caused changes.
- Determine and protect most diverse and high value habitats; Analyze known high quality marine, estuarine, freshwater, and terrestrial areas and immediately protect those with high biodiversity and high potential value to food web.

Preliminary Gap Analysis:

Salmonids

- Examine the linkages between habitat and water quality conditions in urban and urbanizing basins.
- More thoroughly assess predator / prey relationships for all life history stages of each salmonid species.
- Focus research on nearshore and estuarine habitats, primarily in regard to juvenile use of and survivability in these environments.
- Assess adequacy of current restoration practices in improving conditions of salmonid use.

- Work on developing interagency coordination for improving ecological conditions for salmonids at all levels of government.

Marine Mammals

- Develop more detailed studies on the resilience and behavioral responses to ranges in frequency.
- Perform residual toxic accumulations in marine mammals.

Benthos

- More detailed evaluations and characterizations of benthos community assemblages and responses to changing water quality conditions.

Biodiversity

- Expand the knowledge of biodiversity and interaction for intertidal environments.

Invasive Species

- Develop an inventory of invasive species within the Puget Sound.
- Conduct a detailed evaluation on the role that the release of ballast water plays on the introduction of exotic and invasive species into the marine environment.

Aquaculture

- Develop a greater understanding of the impacts of aquaculture on native biological assemblages in the marine environment.

Food web

- Develop a greater understanding of the food web dynamics and interactions in the marine environment.

Topic: Habitat and Land Use

Science Panel input:

- Climate change habitat vulnerability assessment (forecasting, winners, losers resulting from climate change net effect, to steer restoration) (Frank).
- Land use trends in river floodplains (forecasting, habitat changes, hydrology) (Frank).
- Spatial database for wetlands (responding to the big gap pointed out in the recent Times article) (Frank).
- Ecosystem processes influencing and supported by eelgrass communities (we still don't know what's behind some of the trends) (Frank).
- Assessment methodologies for establishing and evaluating marine protected areas (Frank).
- Sediment loading changes in river deltas resulting from land use trends (assessment, drivers including climate, effects; could be linked climate change effects on Puget Sound rivers and streams) (Frank).

Topic Forum Paper:

- Nearshore ecosystem processes and linkages to watershed and marine systems, as well as the effects and implications of human activities on nearshore ecosystem processes and habitats (see goals 1 and 2 in Gelfenbaum et al. 2006).
- Deep-water habitat processes in Puget Sound and how those may be affected by future development such as further shoreline modifications, wastewater discharge, and tidal energy generation (see Beechie et al. 2007).
- The cumulative effects of multiple stressors on processes, habitat structure (i.e., biodiversity, spatial patterns in species abundances), and function.
- Resulting ecosystem process and habitat impacts from climate-induced changes in sea levels, air and water temperatures, precipitation and surface water movement patterns, Puget Sound circulation and water quality (Mantua et al. 2007). Impact assessment should examine risk to specific habitats by location.
- Effects of changes in environmental flow parameters (i.e., flood flows, pulses, base flows, and low flows) on riverine habitat, riparian functions, fish communities, and salmon populations.
- Perform a rapid, landscape-scale assessment across Puget Sound of the status of ecosystem processes, structures and functions.
- Perform a comprehensive species natural history survey. A major limitation in achieving a clear science framework from which to act is the lack of a comprehensive natural history survey for Puget Sound. Such a survey would provide biological information on spatial and temporal distribution of its species and

biological communities, which are both a primary resource, and which serve as an indicator of health for Puget Sound.

- Until a cumulative effects study is complete, create and use an additive model and uniform, qualitative descriptors to assess the status of Puget Sound Ecosystem (i.e., use an additive model) and use more qualitative descriptors of the system state. See, e.g., eastern Jefferson County Nearshore Assessment (Diefenderfer et al.) and the Birch Bay watershed assessment (Stanley et al).
- Consider the conclusions of the NOAA Integrated Ecosystem Assessment for Puget Sound. As this work becomes available, it should be added to the existing scientific knowledge to form the science framework within which we act to restore Puget Sound.

Preliminary Gap Analysis:

- Study impacts of development on habitats and species.
- Conduct stream or nearshore inventories.
- Create sediment budgets and determine the sources and fates of sediments.
- Map various habitats.
- Document the functions of riparian vegetation.
- Assess the relationship between biodiversity, ecosystem health, and productivity.
- Identify and model ecosystem functions.

Topic: Water Quality

Science Panel input:

- Ocean acidification status and trends in Puget Sound (pH, alkalinity, pCO2) (Jan).
- Groundwater nitrogen and water loads (Jan).
- Nearshore nutrient fluxes (Jan).
- Modeling of nutrient processes and sensitivities (Jan).
- Pathogen characterization (Jan).
- Climate change and water temperature in Puget Sound (forecasting both trends and ecosystem effects) (Frank).
- Measuring contaminant bio-magnification in predators (phase II indicator development considering marine mammal, bird, and fish tissue approaches) (Frank).

Topic Forum Paper:

- Temporal and spatial distribution, as well as limited range of pollutants.
- Understanding the widespread distribution of receiving water quality data for pollutants that we know are in surface water runoff, including metals and PAHs.
- Emerging contaminants of concern and their relative importance (or lack of importance).
- Evaluate link between storm water pollutant loads and aquatic organism health; Conditions that produce high concentration storms, including frequency, duration, and magnitude of storm water concentrations that do and do not harm organisms; Study would determine effectiveness of BMPs and how and when they are used, and which BMPs are selected.
- Evaluate role of previously contaminated sediments and Puget Sound health; Effectiveness of sediment cleanup programs, recontamination issues, and regulatory and source control program effectiveness; mechanisms for contaminated sediment to present threat; evaluate and develop sediment cleanup standards.
- Determination of baseline water and sediment conditions; Compile existing data; identify geographic or chemical constituent data gaps; collect baseline data to fill gaps for water and sediment quality in freshwater and marine water bodies.
- Evaluate existing water quality standards; Determine effectiveness of existing water quality standards; Develop site-specific water quality criteria based on water body; Recommend WDOE review and modify existing standards and adopt numeric limits for common pollutants.
- Develop and refine models that simulate circulation patterns in Puget Sound.

- Provide better capabilities for predicting ecological and human health outcomes of specific recovery actions in specific geographical areas; Help prioritize actions; Identify gaps and uncertainties in knowledge.
- Determine dynamics and levels of nutrients from natural sources and undeveloped landscapes; how nutrients affect the food web (phyto- and zooplankton); how N and P affect biological communities and algal blooms; role of groundwater in nutrient delivery to nearshore.

Preliminary Gap Analysis:

- Storm water as a source of pollutants, examining differences of effects based on land uses, storm water conveyance systems and watersheds. This includes linking storm water to receiving water body conditions and aquatic health, as well as quantifying the relative contribution of storm water to receiving water body conditions compared to other sources.
- Atmospheric deposition of pollutants.
- Pathways and loading rates for nutrients, toxics, and pathogens based on various land uses, and other influencing factors. This has much overlap with questions about storm water as a carrier of these compounds. Studies should trace pollutants through the food web to identify ultimate effects on high level predators (e.g., orcas, seals) and people.
- Effects of toxic contaminants on aquatic communities and species, including newly emerging threats like endocrine disruptors and sources like personal care products.
- Low dissolved oxygen levels in Hood Canal and associated contributing factors and environmental responses.
- The influence of contaminated sediments on aquatic health and better understanding of locations and magnitude of contamination.
- The inventory included a limited number of storm water management best management practice effectiveness studies, although the effectiveness monitoring is being addressed separately.
- Scenario development that incorporate projects of human population growth, climate change, and the quantity and distribution of water-borne contaminants.

Topic: Water Quantity

Science Panel input:

- Climate change and hydrology in Puget Basin rivers and streams (forecasting both trends and ecosystem effects) (Frank).
- Hydrological consequences of glacial retreat in the Puget Basin (Frank).
- Instream flow ecological needs (connecting climate change influences on hydrology, habitat/species requirements, current and projected human diversions) (Frank).

Topic Forum Paper:

- High and low flow requirements for aquatic species and connections to other elements of the ecosystem.
- Regional assessment of the adequacy of flow variations for optimum habitat function.
- Summarize the number of watersheds with flow modeling that accounts for climate change; Determine the number of large water systems that have used surface water data from modeling to predict impacts on firm yield.
- Study localized hydraulic continuity between surface water and groundwater.
- Collect data that indicates groundwater levels, trends, and depletion on a regional scale.
- Determine quantitative understanding of geomorphology and fish needs during high flows.
- Identify flow impairments in Puget Sound watersheds.
- Evaluate freshwater requirements for estuary health.
- Develop WRIA-based inventories to determine where low and high flow problems occur; Establish relationship between flows and viable salmonid populations; Identify salmonid recovery flow targets; Coordinate this work with State efforts.
- Analyze stream flow trends for all major Puget Sound tributaries and compare to instream flow rule; Identify metrics that indicate benefits of flow improvements and quantify by species; Collect data that will quantify benefits of flow improvement for species.
- Codify new or revised instream flow rules for all mainstem rivers and major tributaries for use in water supply management; Assess and prioritize flow impairments in a target number of WRIAs; Estimate and codify salmon recovery flow targets.
- Determine the number of illegal water users and percent of water use currently metered.

- Determine quantitative correlation between stream flow and fish productivity.
- Determine quantity of water to meet consumptive needs.
- Regional survey of water system plans and watershed plans.
- Estimate quantity of ground and surface water use and future availability by WRIA or action area; Integrate findings with reclaimed-water and storm water planning.
- Compile regional summary or current water use, projected water use, and water supply; Identify a target number of ASR and desalinization projects and equivalent stream flow savings; Determine the percent of water system plans that have adequate water supply to meet the 2020 threshold.
- Determine range of freshwater inputs to maintain healthy habitats; Assess total freshwater inputs to Sound and trends in low and high flow inputs over time; Assess channel morphology and flows, salinity levels, and circulation.
- Determine the number of water supply management plans developed.

Preliminary Gap Analysis:

- Trend monitoring to assess seasonal and annual changes to groundwater on a regional scale. This is a long-term commitment.
- There is a distinct need for developing quantitative relationships that formalize models for establishing instream flows and setting benchmarks for species productivity.
- There needs to be a regionally consistent approach to assess water use, future water needs, and availability.
- Also, there is a need for identifying new sources and methods for maximizing consumption while maintaining needs for fish habitat.
- Comparing projections of water use/needs and modeled predictions of availability.
- Sea-level change.